Lookback: Sandia ParaChoice Model

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Overview

Purpose of the model?

How does the model work?

How has the model evolved?

What have we learned looking back?

How has looking back pointed us forward?
Purpose of the model?

- Understand composition of US LDV stock through 2050
  - AEVs compete for market share given technology and fuel costs and vehicle inconveniences
  - Tracks GHG emissions and fuel use
Purpose of the model?

- Understand composition of US LDV stock through 2050
  - AEVs compete for market share given technology and fuel costs and vehicle inconveniences
  - Understand GHG emissions and fuel use
- Sensitivities to commodity prices, technology advancements, policy ...

![2050 BEV Sales Fraction](chart)
Purpose of the model?
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How does the model work?
## Consumer/Vehicle Stock

### Powertrain
- SI
- SI Hybrid
- SI PHEV10
- SI PHEV40
- CI
- CI Hybrid
- CI PHEV10
- CI PHEV40
- CNG
- CNG Hybrid
- CNG Bi-fuel

### State
- 48 CONUS + Washington, DC

### Density
- Urban
- Suburban
- Rural

### Size
- Compact
- Midsize
- Small SUV
- Large SUV
- Pickup

### Age
- 0-46 years

### Driver Intensity
- High
- Medium
- Low

### Housing type
- Single family home without NG
- Single family home with NG
- No access to home charging/fueling

## Generalized Vehicle Cost

### recurring Costs
- Fuel
- Annual incentives
- Range penalty:
  - $ value of time X time spent refueling

### Amortized Upfront Costs
- Purchase Price
- One time incentives
- Infrastructure penalty:
  - $ value \( \exp[-a n_j/n_{gas}] \)
- Value of model diversity:
  - \( \ln(m_j/m_{SI}) \)

### Nested Logit Choice Function for Powertrain Selection

### SALES
Purpose of the model?

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How does the model work?

- Feedback between energy and vehicle stock

Vary around inputs from AEO, Autonomie, and more

No one projection is guaranteed to be correct- but we can probe sensitivities, trade space
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How does the model work?
- Feedback between energy and vehicle stock
- Run thousands of times to create scenario library and probe sensitivities

How has the model evolved?
How has the model evolved?

- 2010: internally funded program to understand energy / LDV stock dynamics
- Added vehicle technologies

Continual updates for evolving input data:

- Autonomie projections, AEO projections, vehicle registration data, GREET emissions, state laws and incentives, refueling station densities
- Added ‘validation’ capability – allows lookback analysis

The implications of modeling range and infrastructure barriers to battery electric vehicle adoption. *Transportation Research Letters* 2015
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How has the model evolved?
- Capability, technology additions – response to OEMs, to support new projects
- Data updates – to support new work and keep model current

What have we learned looking back?

Study: Compare simulated and actual sales fractions of AEVs from 2010

Remove uncertainty by looking back (rather than parameterizing):
- Energy and fuel prices
- State of technology
- Policy
- Consumer demographics
Diesel vehicles - simulation capturing trends and scales, vehicle model availability is very important

Simulations using historical data for energy prices, technology costs, and actual model availability

But simulated model availability

Simulation is capturing consumer responses to changes in commodity prices and other market factors. We CAN capture sensitivities.

Garbage in, garbage out: if input projections are off, so are the output projections.
Hybrid Vehicles- simulation capturing long term trends and scales

Non-Luxury (< $70k) Model Availability

2011 Tsunami
PEVs – model availability is important, early adopter segment may be

Simulation matches less well if all models considered.

Simulation matches better if only non-luxury models considered.

Though there are obviously still some un-captured trends.
Conclusion

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What have we learned looking back?
- Simulation captures trends in consumer behavior, scales of sales
- Vehicle model availability is important and complex to model
- Early adopter segmentation is likely important

How has looking back pointed us forward?
- Have added confidence in the simulation dynamics
- Will incorporate early adopter segment, look carefully at model availability
BEVs—early adopter segment is important to simulate
Purchasing incentives are important to consumers.
PHEV makes, models, and approximate ranges and prices

<table>
<thead>
<tr>
<th>Make &amp; Model</th>
<th>eRange  (miles)</th>
<th>MSRP  ($1000)</th>
<th>Years</th>
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<tbody>
<tr>
<td><strong>PHEV10s (25mi or less eRange)</strong></td>
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<td>BMW i8</td>
<td>15</td>
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<td>Fisker Karma</td>
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<td>102</td>
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Publications


Barter GE, Tamor MA, Manley DK & West TH (2015). The implications of modeling range and infrastructure barriers to battery electric vehicle adoption. *Transportation Research Letters*, 2502, 80-88